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WAR FOOD ADMINISTRATION
U.S. Food Distribution Administration
Transportation and Warehousing Branch

PRECOOLING AND REFRIGERATION TESTS

ON

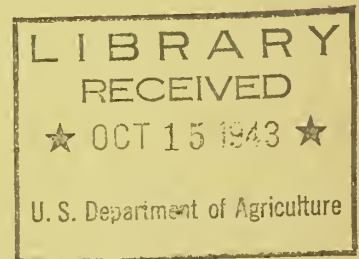
FROZEN FRUITS AND VEGETABLES FROM HILLSBORO, OREG. AND WENT, WASH.

TO JERSEY CITY, N. J.

JULY 11 TO JULY 26, 1943 INCLUSIVE

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Transportation Rates and Services Division

Washington, D. C.
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The Frozen Food Industry requested the Food Distribution Administration with the cooperation of the Bureau of Plant Industry Soils and Agricultural Engineering, to make several refrigeration and precooling tests on its commodities in order to determine the most effective method of refrigeration to be used at different seasons of the year. The first test was made last March. The test just completed is the second, and the Frozen Food Industry has requested that another test be made in November. The results of these tests will give a fair average as to the amount of ice and salt required to ship frozen fruits and vegetables during all seasons of the year.

The test reported on herein consisted of 6 cars of frozen fruits and vegetable 4 cases were loaded at Hillsboro, Ore., and 2 cars at Kent, Wash. The routing to Jersey City, N. J. was over the Spokane, Portland, and Seattle Railroad to Spokane, Wash.; Great Northern Railroad to the Minnesota Transfer; Chicago, Burlington and Quincy Railroad to Chicago; and the Pennsylvania Railroad to Jersey City, N. J.

Refrigerator cars of the Fruit Growers Express and the Western Fruit Express were used in the test. The 4 Western Fruit Express cars were constructed with bunkers in the ends of the cars and the 2 Fruit Growers Express cars had overhead bunkers. Bunkers of the refrigerator cars are compartments either at the ends of the car or built in the ceiling, which accommodate from 9,000 to 12,000 pounds of ice, with openings at the top and bottom to allow the circulation of air over the ice to refrigerate the lading. All cars used in the test were of the super giant series of which detailed specifications are shown in the following table:

CAR NOS.	WFE 423, 429, 432 & 446	FGE 607 & 609
Loading Space-Length	42' - 6"	50' - 0"
Width	8' - 6"	8' - 3"
Height	7' - 4 1/8"	6' - 8 1/2"
Cu.ft.	2,652	2,908
Floor Rack Height	5 7/8"	4 13/16"
Side Wall Racks	1 1/2" each side	None - Inner flues
End Wall Racks	Bunker bulkhead	3/4' Vertical strips
Bulkhead Openings-Top	12 1/2"	
Bottom above)	Closed, except WFE	
floor racks)	429 open 6 1/8"	
	above racks	
Insulation-Floor	6"	8"
Side-End wall	6"	6 1/2"
Roof	6"	8"
Bulkheads	1"	
Bunkers - Type	Divided flue basket	Overhead tanks (10)
Capacity	10,800 _{lb} Coarse ice	9,000 _{lb} crushed ice
Length	2' - 7 1/2"	9' - 0"
Width	2 @ 3' - 11 3/4" per end	3' - 3"
Height	6' - 9"	9 1/2" avge
Cu. ft. per car	262	232

OCT 13 1943

Where scales were available for weighing the ice furnished for initial icing and reicing, actual weights were obtained and used in this computation. In some cases, where scales were not available, it was necessary to estimate the amount of ice placed in the bunkers, and these estimates were calculated by the number of inches that the ice had melted from the top of the bunker.

Coarse ice was used for the purpose of precooling and refrigeration in transit for the end bunker cars, and crushed ice was used for the same purpose in the overhead bunker cars. Definitions of coarse and crushed ice, as published in Item No. 1152 of the National Perishable Protective Tariff No. 12 - ICC No. 19 are as follows:

CRUSHED ICE is ice broken into pieces averaging the size of a man's fist.

COARSE ICE is ice broken into pieces averaging 10 to 20 pounds.

All the cars were shipped under standard refrigeration with various percentages of salt. Standard refrigeration is a protective service against heat, furnished by the railroads, by the use of ice in the bunkers of refrigerator cars. Under this service, the bunkers are filled to capacity with ice at all the regular icing stations on the route traveled. These icing stations are generally located along the right-of-way at approximately 24 hours of running time apart. On frozen commodities for which salt is used to increase the refrigeration, the salt is also furnished at each icing station.

The charges for standard refrigeration service are shown in Section 2 of the National Perishable Protection Tariff.

In order to determine the temperatures of the frozen commodities and the air at various locations inside of the cars, 12 electric resistant thermometers were placed in each car. The thermometer bulbs were placed between the small packages inside the fiber body cartons, the cartons were then closed and placed in the desired location of the load. Each thermometer cable was then connected to a master cable which extended out through the top of the closed door to the roof of the car, where reading instruments were connected and temperature readings were recorded in transit. The locations of the 12 thermometer cables were the same in all 6 cars, located as follows:

Bulb No. 1 -	Commodity	-	Bottom layer container side wall at the bulkhead.
Bulb No. 2 -	Air	-	Bottom at floor rack side wall at the bulkhead.
Bulb No. 3 -	Air	-	Bottom at floor rack center of load at bulkhead.
Bulb No. 4 -	Air	-	Top, above load, side wall at bulkhead.
Bulb No. 5 -	Commodity	-	Top, layer container side wall at the bulkhead.
Bulb No. 6 -	Commodity	-	Bottom layer container quarter length of side wall.
Bulb No. 7 -	Commodity	-	Top layer container quarter length at the side wall.
Bulb No. 8 -	Air	-	Top above load quarter length center of load.
Bulb No. 9 -	Air	-	Top above load at doorway side wall.
Bulb No. 10 -	Commodity	-	Top layer container at doorway side wall.
Bulb No. 11 -	Commodity	-	Bottom layer container at doorway side wall.
Bulb No. 12 -	Air	-	Bottom at floor rack doorway side.

METHOD OF REFRIGERATION AND PRECOOLING

FGE 607 - Precooled 21.1 hours prior to loading. Shipped standard refrigeration plus 20 percent salt.

FGE 609 - Precooled 19.5 hours prior to loading. Shipped standard refrigeration plus 30 percent salt.

WFE 429 - Precooled 46 hours prior to loading. Shipped standard refrigeration plus 30 percent salt.

WFE 432 - Precooled 14 hours prior to loading. Shipped standard refrigeration plus 30 percent salt.

WFE 423 - Precooled 20.8 hours prior to loading. Shipped standard refrigeration plus 20 percent salt. The billing was changed enroute to 30 percent salt.

WFE 446 - Precooled 24.3 hours prior to loading. Shipped standard refrigeration plus 30 percent salt.

Precooling prior to loading at shipping point was accomplished by using ice and salt to extract the heat from the body of the car at various periods of time as indicated in the following table.

RELATIVE TIME OF CAR PRECOOLING

CAR	FGE 609	FGE 607	WFE 432	WFE 446	WFE 429	WFE 423
Salt (Percent)	30	20	30	30	30	20
Hrs. *						
Cooled	19.5	21.1	14.0	24.3	46.4	20.8
Date & Time						
July, 1943	<u>Ex. Avg.</u>	<u>Max. Avg.</u>	<u>Max. Avg.</u>	<u>Max. Avg.</u>	<u>Max. Avg.</u>	<u>Max. Avg.</u>
11-3:05P 0	62.0	60.4				
11-10:50A 0		55.9	55.5			
12-3:30P 0			67.8	66.5		
13-1:50P 0				67.2	66.2	
11-11:50A 0					61.2	60.3
13-11:20A 0						69.4
13-3:30A 14			28.7	24.1		68.2
12-2:00A 14					26.0	22.5
12-10:40A 13.5	16.8	15.5				
14-8:10A 20.8						24.2
12-8:00A 21.8		19.4	17.9			19.1
14-2:10P 24.3				20.5	15.6	
12-11:45A 24.0					20.0	17.0
12-7:00 P 31.1					Reiced	
12-10:00P 34.1					21.0	17.4
13-10:15A 46.4					18.6	15.4
Reduction	44.9	37.6	42.4	50.6	44.9	49.1
Outside Temp.						
During Cooling	48°-60°	48°-68°	52°-76°	55°-86°	48°-72°	55°-86°

NOTE* Composed car cooling period from time icing was completed. Initial temperatures shown recorded prior to initial icing.

The above records show that longer periods than 24 hours for precooling do not seem necessary as the cars which were precooled 24 hours or, in some instances, less, carried just as good transit temperatures as the cars which were precooled longer than that period of time.

In making the following comparisons of air temperatures before loading and after loading, using the same four positions in each car, the top and bottom temperatures at the end of the car and the top and the top and bottom temperatures at the doorway should be the highest and lowest points in the car.

In some cases, however, there was quite a loss of the effects of the precooling during the loading periods. The following explanations show such variations for each car:

- FGE 609 - had an average air temperature of 15.8° F. at 10:45 AM on July 12, prior to opening the doors for loading. At 2:30 PM that afternoon, the air temperature after loading had been completed ranged from 21.7° F. to 14.4° F. averaging 18.1° F. showing a loss of 3.4° F.
- FGE 607 - had an average air temperature of 22.4° F. at 8:30 AM on July 12, prior to opening the doors for loading. At 10:45 AM the same morning, the air temperature after loading had been completed ranged from 38.7° F. to 15.2° F. averaging 29.3° F. showing a loss of 6.9° F.
- WFE 432 - had an average air temperature of 23.7° F. at 8:30 AM July 13, prior to opening the doors for loading. At 10:20 AM the same morning, the air temperature after loading had been completed ranged from 23.6° F. to 13.9° F. averaging 29.7° F. showing a loss of 5.7° F.
- WFE 446 - had an average air temperature of 11.0° F. at 2:10 PM on July 14, prior to opening the doors for loading. At 5:05 PM the same afternoon, the air temperature after loading had been completed ranged from 42.6° F. to 09.5° F. averaging 26.8° F. showing a loss of 15.5° F.
- WFE 429 - had an average air temperature of 15.2° F. at 10:15 AM on July 13, prior to opening the doors for loading. At 1:30 PM the same afternoon after loading had been completed, the air temperature ranged from 40.4° F. to 11.6° F. averaging 26.01° F. showing a loss of 10.9° F.
- WFE 423 - had an average air temperature of 18.5° F. at 8:10 AM on July 14, prior to opening the doors for loading. At 11:45 AM the same morning after loading had been completed, the air temperature ranged from 43.2° F. to 16.3° F. averaging 29.7° F. showing a loss of 11.2° F.

A great amount of this lost refrigeration could be saved in the cars if a portable tunnel were used. Such a tunnel designed to fit tightly from the opening in cold storage warehouse into the car, with a curtain made of kapoc or dry zero hung over the doorway and extended down to the floor rails with weights to hold it securely to the floor and against the walls, will seal the doorway and prevent outside heat from entering. The curtain should have an opening in the middle for the tunnel to enter into the car. For convenience, the tunnel could be constructed on wheels or large casters in order to facilitate the moving from one location to another on the loading platform.

The following table indicates the air temperatures maintained in transit at the designated positions of the test cars from the point of origin to destination.

(see attached tables of air temperatures)

WFE 423 was originally billed "standard refrigeration plus 20 percent salt." However, as the temperature records show, the product was not frozen to a low enough degree. After making a careful study of the air and commodity temperatures, the refrigeration instructions were changed at Williston, N. Dak., to include 30 percent salt.

The cost of transporting frozen fruits and vegetables from Oregon and Washington to Jersey City, N. J., on each of the test cars, was as follows:

CAR NO.		BILLING WGT.		FRT. RATE	TOTAL CHGS.
FGE 607	- 65 cs. 48/14 Rhubarb @ 49 ¹¹ / ₁₆ ca	3184			
	372 cs. 48/16 Straw. 55 ¹¹ / ₁₆ ca	20460			
	258 cs. 48/12 Asparagus 42 ¹¹ / ₁₆ ca	10836			
	1096 cs. 48/14 Spinach 49 ¹¹ / ₁₆ ca	53704			
	Total Gross Weight	88185 ¹¹ / ₁₆ @	\$ 1.16	\$ 1,022.95	
	Standard Refrigeration plus 20% Salt			112.00	
				\$ 1,134.95	
FGE 609	- 343 cs. 72/12 Peas @ 65 ¹¹ / ₁₆ ca	22295			
	1218 cs. 48/16 Straw. 55 ¹¹ / ₁₆ ca	66990			
	Total Gross Weight	89285 ¹¹ / ₁₆ @	\$ 1.16	\$ 1,035.71	
	Standard Refrigeration plus 30% Salt			120.00	
				\$ 1,155.71	
WFE 429	- 1681 cs. 48/14 Spinach @ 49 ¹¹ / ₁₆ ca	82369 ¹¹ / ₁₆ @	\$ 1.16	\$ 955.48	
	Standard Refrigeration plus 30% Salt			120.00	
				\$ 1,075.48	
WFE 432	- 1681 cs. 48/16 Straw. @ 55 ¹¹ / ₁₆ ca	92455 ¹¹ / ₁₆ @	\$ 1.16	\$ 1,072.48	
	Standard Refrigeration plus 30% Salt			120.00	
				\$ 1,192.48	
WFE 423	- 500 cs. 6/5 Peas @ 33 ¹¹ / ₁₆ ca	16500			
	1077 cs. 48/12 Peas 42 ¹¹ / ₁₆ ca	45234			
	Total Gross Weight	61734 ¹¹ / ₁₆ @	\$ 1.16	\$ 716.11	
	Standard Refrigeration plus 30% Salt			120.00	
				\$ 836.11	
WFE 446	- 200 cs. 48/12 Rasp. 41 ¹¹ / ₁₆ ca	8200			
	100 cs. 48/16 Sliced Straw. 55 ¹¹ / ₁₆ ca	5500			
	150 cs. 48/16 Whole Straw. 55 ¹¹ / ₁₆ ca	8250			
	600 cs. 48/12 Peas 42 ¹¹ / ₁₆ ca	25200			
	553 cs. 6/5 Peas 33 ¹¹ / ₁₆ ca	18249			
	Total Gross Weight	65399 ¹¹ / ₁₆ @	\$ 1.16	\$ 758.63	
	Standard Refrigeration plus 30% Salt			120.00	
				\$ 878.63	

(The above does not include 3% Government Tax)

The cost of ice and salt for precooling and transit icing on basis of Section 4 charges of the National Perishable Protective Tariff including accessorial charges are shown on the attached statements.

